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BRL

MEMORANDUM REPORT No. 564

Table Of Form Factors Of Projectiles

H. P. HITCHCOCK

ORDNANCE RESEARCH AND DEVELOPMENT PROJECT No. TB3-0430AD

BALLISTIC RESEARCH LABORATORIES

ABERDEEN PROVING GROUND, MARYLAND

B A L L I S T I C R E S E A R C H L A B O R A T O R I E S

MEMORANDUM REPORT NO. 564

October 1951

TABLE OF FORM FACTORS OF PROJECTILES

H. P. Hitchcock

Project No. TB3-0430AD of the Research
and Development Division, Ordnance Corps

A B E R D E E N P R O V I N G G R O U N D, M A R Y L A N D

BRL MR 564

Tables of Form Factors of Projectiles

Supplement 1 June 1952

Gun	Projectile	Fuze	Weight lb	Velocity fps	Ball. Coef.	Form Factor	Proj. Type
75mm How M3	HEP T150E11	BD M91	8.76	1760	1.04	0.97	1
76mm Gun M1A2	HEP T170E3	BD M91	9.93	2506	1.15	0.96	1
90mm Gun M3	HEP T142E3	BD M91	15.8	2426	1.16	1.08	1
	HEP T142E5	BD M91	17.2	2434	1.40	0.98	1
	AP T33E5	Tracer	23.7	3178	1.59	1.19	6
	AP T33E7	Tracer	24.1	3050	1.61	1.19e	6
	HEAT T108E15	PI T209	14.5	2324	1.85	0.625	1
	HEAT T108E45	PI T209	14.5	2689	1.96	0.59	1
90mm Gun T119	HEP T142E3	BD M91	15.9	2582	1.34	0.94	
	HEAT T108E15	PI T209	14.5	3173	1.78	1.65	
	HVAP T137		9.9	4103	3.52	0.50a	1
105mm Rifle M27	HE T268	PD M503	16.9	1700	2.55	1.60e	2
	WP T269	PD M503	16.9	1700	2.55	1.60e	2
	HEAT T184E3	BD M91	16.8	1688	1.29	0.76	1
	HEAT T138E57A	BD M91	17.4	1646	0.54	1.90	8
105mm Rifle T137	HEAT T171 MD11	BD M91	17.5	1675	0.81	1.26	1
105mm How M4	HEP T81E28	BD M91	23.5	2066	1.42	0.97	1
120mm Gun T123	AP T147E1 b		50.0	3518	2.08	1.09	8
	AP T147E1 c		49.6	3307	1.69	1.33	8
155mm Gun M2E1	HE T45E3	PD M51A4	95	2800	2.507	1.02	2
	HE T45E4, E5	PD M51A4	95	2800	2.60	0.98	2

a Diameter of Shot in Flight 2.36 in. (60mm)
b Windshield welded to shot
c Windshield welded to adaptor
e Estimated.

B A L L I S T I C R E S E A R C H L A B O R A T O R I E S

MEMORANDUM REPORT NO. 564

HPHitchcock/lbe
Aberdeen Proving Ground, Md.
25 October 1951

TABLE OF FORM FACTORS OF PROJECTILES

ABSTRACT

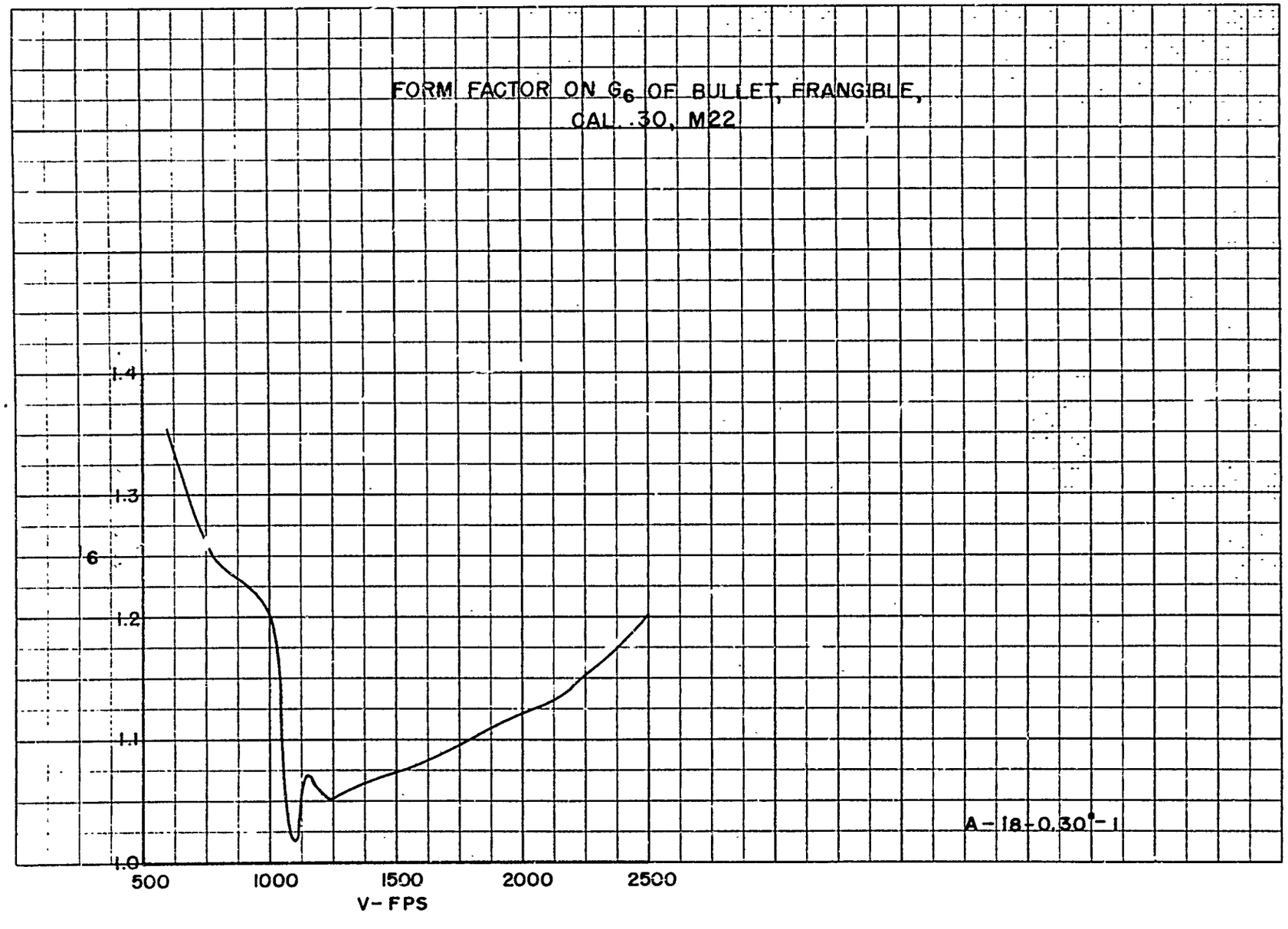
This is a revision of Table VII, Ballistic Research Laboratories Report No. 284, "Form Factors of Projectiles" (1942), and supplements thereof. The values in the present revision supersede those in the earlier editions with which they conflict. Some form factors with respect to specific projectiles are tabulated: in order to obtain the form factor with respect to a typical projectile, multiply these by the form factor of the specific projectile which is plotted as a function of velocity. Graphs of the form factors of beveled slugs and a sphere are also included.

LIST OF GRAPHS

Form Factors of Projectiles

Gun	Projectile	Weight gr.	Velocity fps	Ball. Coef.	Form Factor	Proj. Type
.30" (7.62mm) BMG M1917A1 BMG M1919A4 BMG M1919A5 BMG M2 BAR M1918A2 USR M1903 USR M1903A1 USR M1917 USR M1	Ball M1906	150	2700	.400	.60	1
	Ball M2 (Std. & Alt.)	150	2740a	.21	1.13	6
	AP M2	164	2730b	.283	.92	5
	Tracer M1 (Std.)	150	2700a	.355	.67	5
	Tracer M1 (Alt.)	142	2700a	.301	.75	5
	Tracer M25 (Night)	150	2650	.294	.81	5
	Incendiary M1	137	2950a	.181	1.20	6
	Frangible M22 (T44)	108.5	1360	.155	1.11	M22
Sub-caliber Rifle M1903A2, Sub-caliber BMG M1917A1	Sub-caliber M1925	172	2025	.317	.86	5
Carbine M2, Carbine M3	Carbine, Ball M1					
	(gilding metal jacket)	110	1860a	.179	.975	1
	(g.m. clad steel jacket)	107	1860a	.174	.975	1
	Carbine, AP	84		.137	.975e	1
	Carbine, Tracer, M27	110	1800b	.179	.975e	1
.45" (11.4mm) Thompson Sub-machine Gun M1928A1, Gun M1, M1A1 Pistol M1911 Pistol M1911A1 Revolver M1917 Sub-machine Gun M3	Ball M1911	230	800c	.112	1.45*	1
	Tracer M26	210	850c	.102	1.45e	1

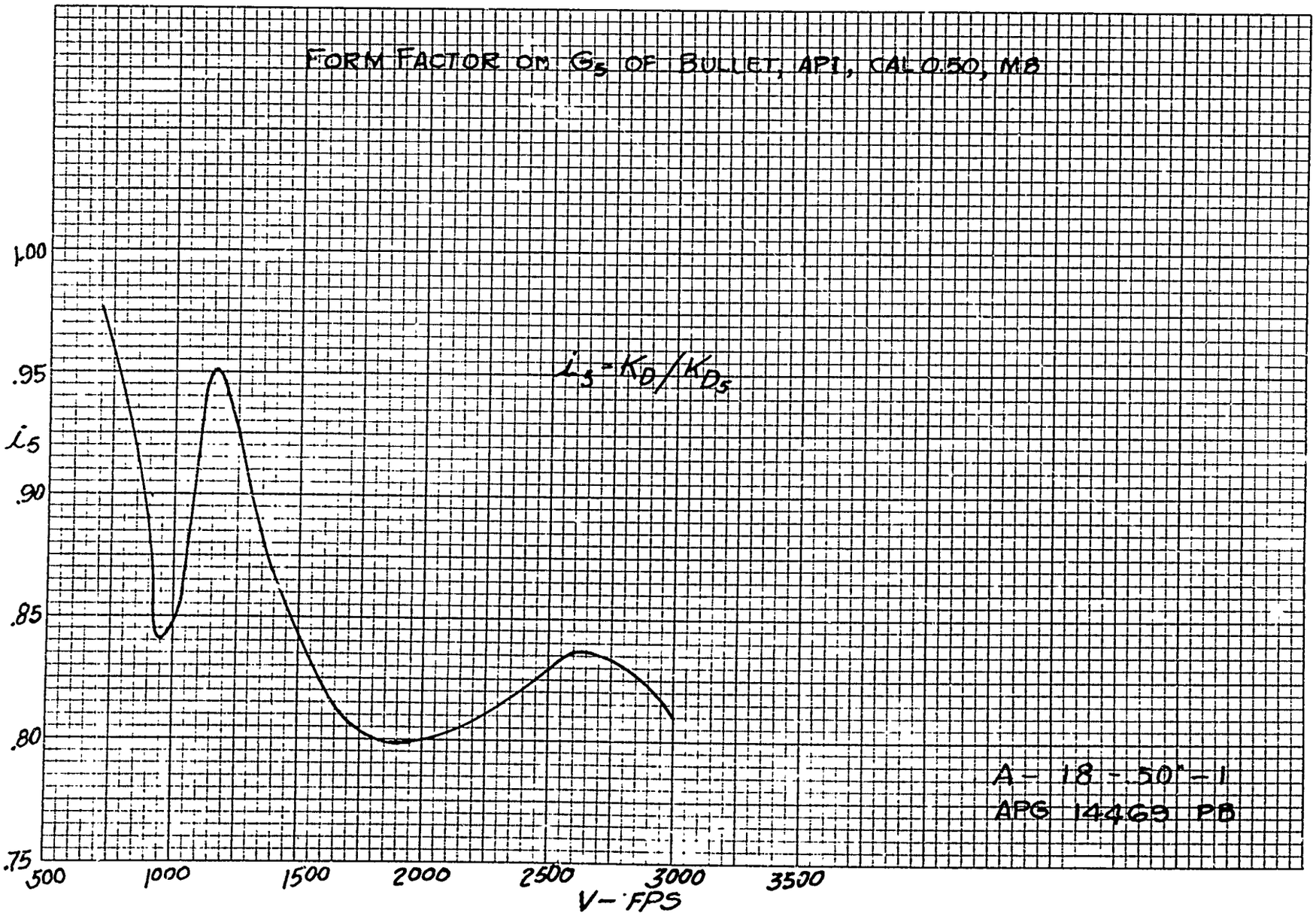
a Standard instrumental velocity at 78 ft.
b Standard instrumental velocity at 53 ft.
c Standard instrumental velocity at 25 ft.
e Estimated
* Determined by resistance firings.


FORM FACTOR ON G_6 OF BULLET, FRANGIBLE,
CAL. .30, M22
1.4
1.3
6
1.2
1.1
1.0
500
1000
1500
2000
2500
V-FPS
A-18-0.30°-1

Form Factors of Projectiles

Gun	Projectile	Weight gr.	Velocity fps	Ball. Coef.	Form Factor	Proj. Type
.50" (12.7mm) BMG M2 BMG M2A1 BMG M3	Ball M1923	802	2525	.612	.75	5
	Ball M1	750	2800d	.542	.79	5
	Ball M2 (Std.)	703	2900f	.461	.87	5
	Ball M2 (Alt.)	698	2900f	.458	.87	5
	Ball M33	650	2910h	.359	1.03e	API M8
	AP M1	750	2800d	.542	.79	5
	AP M2 (Std.)	710	2900f	.4715	.86	5
	AP M2 (Alt.)	698	2900f	.458	.87	5
	API M8	650	2910h	.359	1.03	API M8
	API T49	501	3460	.223	1.29	7
	APIT M20	614	2900	.437	.80	5
	Tracer M1 (Std.)	674	2800d	.467	.825	5
	Tracer M1 (Alt.)	635	2800d	.446	.81	5
	Tracer M10	640	2860h	.450	.81	5
	Headlight Tracer M21	696	2762j	.574	.69	5
	Incendiary M1	625	2950h	.387	.92	6
	Incendiary M23	512	3400j	.232	1.26	7
.60" (15.2mm) Gun	Ball T32	1200	3550	.382	1.25	7
	Ball T32E2	1140	3600	.368	1.23	7
	Ball T77	1140	3550	.356	1.265	8
	AP BC-3	1180	3584	.373	1.255	7
	Tracer BC-3	1100	3579	.361	1.21	7
	API T39	1140	3550	.360	1.25	8
	APIT T69	1050	3570	.358	1.16	7
	Incendiary T31	1200	3590	.404	1.18	7
	Incendiary T36	1140	3550	.351	1.29	7
	Incendiary T36E2	1140	3550	.354	1.28	8
	APIT T76	1050	3570	.366	1.14	8

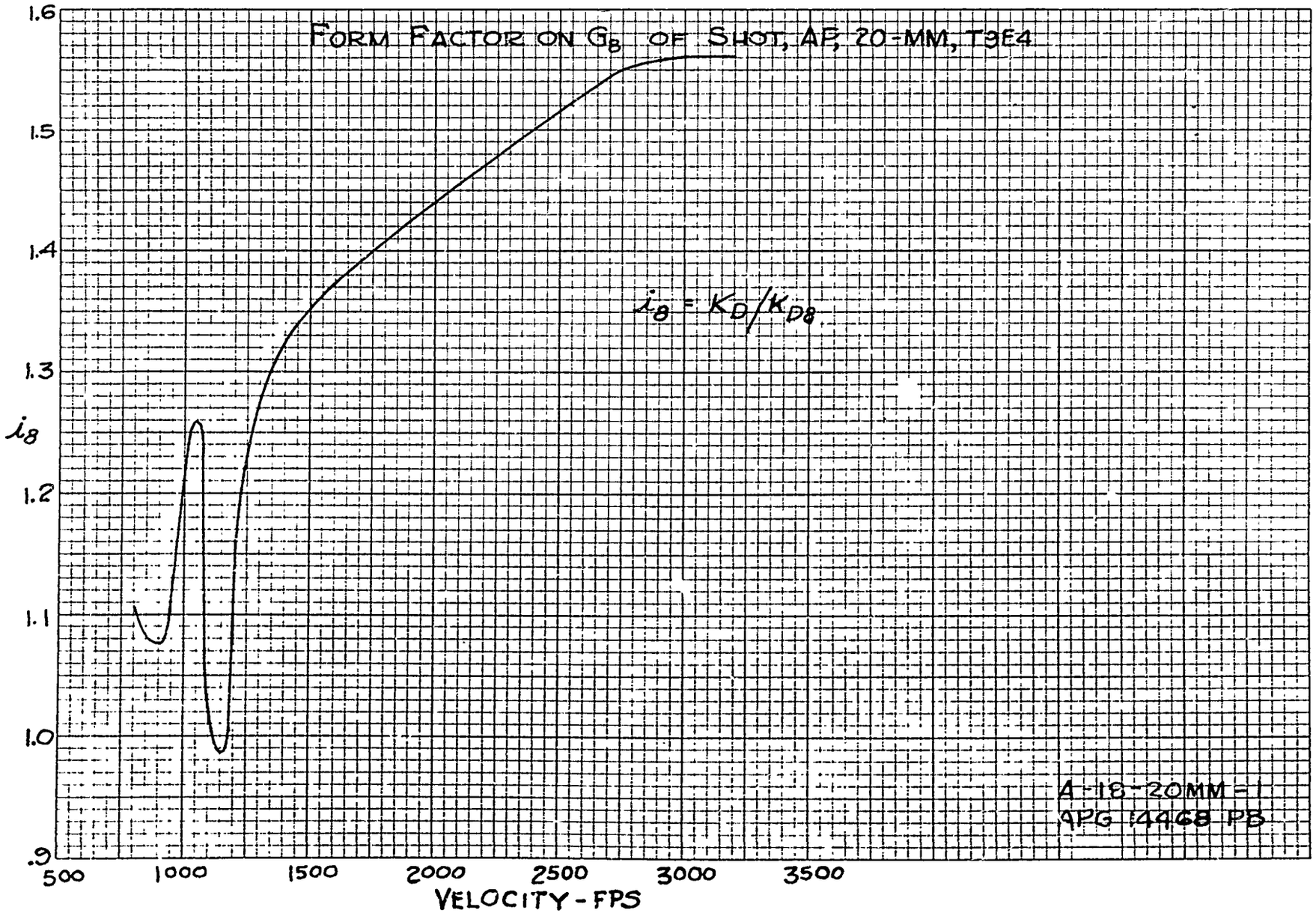
d Standard muzzle velocity with 45" barrel
e Estimated
f Standard instrumental velocity at 78 ft.: 2900 fps with 45" barrel
2810 fps with 36" barrel
h Standard instrumental velocity at 78 ft. with 36" barrel
j Standard instrumental velocity at 78 ft.


FORM FACTOR ON G_5 OF BULLET, API, CAL 0.50, MB
$i_5 = K_D / K_{D_5}$
1.00
.95
i_5
.90
.85
.80
.75
500
1000
1500
2000
2500
3000
3500
V - FPS
A - 18 - .50" - 1
APG 14469 PB

Form Factors of Projectiles

Gun	Projectile	Fuze	Weight gr.	Velocity fps	Ball. Coef.	Form Factor	Proj. Type
20mm (.787") Aircraft Automatic Gun AN-M2	Ball Projectile		2000	2850	.472	.98*	1
	Ball Projectile T4	Tracer	2542	2530	.612	.96	1
	AP Shot M75	Tracer	2548	2550	.298	1.98	6
	AP Shot T9E4	Tracer	2000	890 to 3070	.462	1.00*	AP T9E4
Automatic Gun M3, Gun M23 Gun M24 Gun M24E2	AP Shot M95	Tracer	2000	3000	.413	1.12	5
	AP Shot M95	w/o T	2000	3000	.401	1.15	5
	API Shot T21	w/o T	1980	2700	.384	1.19	5
	API Shot T21E1		2000	2700	.488	0.945	AP T9E4
	API Shot T69		1600	3110	.427	0.87	AP T9E4
AA MG Mark IV	HE Shell (Dwg. TAM292)	PD T200	1565	3500	.272	1.33e	7
	HEI Shell Mk I	Perc. No. 253	2030	2800	.459	1.02	1
	HEI Shell T16	Tracer	1900	2800	.403	1.09	5
	HEI Shell M97	PD M75	2039	2800	.520	0.90	AP T9E4
	HEI Shell T39	PD T200	1500	3270	.269	1.24	8
	HEI Shell T39E2	Plug	1700	3045	.320	1.22	8
	HEI Shell T68	PD T200	1600	3080	.4155	0.89	AP T9E4
	Inc. Shell M96		1920	2800	.383	1.16	5
	Inc. Shell T28		1500	2700 3200	.270	1.28	8
	Inc. Shell T35		1200	2620 3650	.220	1.26	8
	Practice Proj. M99		2000	2800	.506	0.91	AP T9E4
	Practice Proj. T61E1		1600	3135	.307	1.20	8
Gun T118 (Navy)	API Shot T90E1 (T133)		1700	3300	.339	1.16	8
	HE Shell T124 (T215)	Dummy T201E1	1615	2936	.284	1.31	8
	Practice Proj. T114 (T130)		1700	3340	.306	1.28	8

* Determined by resistance firings
e Estimated


FORM FACTOR ON G_8 OF SHOT, AP, 20-MM, T3E4
$i_8 = K_D / K_{D8}$
i_8
1.6
1.5
1.4
1.3
1.2
1.1
1.0
.9
500
1000
1500
2000
2500
3000
3500
VELOCITY - FPS
A-18-20MM-1
9PG 14468 PB

Form Factors of Projectiles

Gun	Projectile	Fuze	Weight lb.	Velocity fps	Ball. Coef.	Form Factor	Proj. Type
37mm (1.457") Gun M1916 and sub-caliber Guns and Tubes	HE Shell Mark 2	BD M38	1.25	1259b	.66	.89*	1
				1530	.64	.92*	1
				1926	.65	.91*	1
	Practice Shell M94	Base plug	1.05		.56	.89e	1
	Practice Shell M92	PD M74	1.25	1276b	.48	1.22e	1
Automatic (antiaircraft) Gun M1A2	HE Shell M54	PD M56	1.34	1300 to 2550b	.631	1.00*	HE M54
		Plug 75-14-309A	1.34	1900 to 2600		a e	1
Tank Gun M6	Practice Shell M55A1	Dummy M50	1.34	b	.631	1.00e	HE M54
		Plug 75-14-309A	1.34	1900 to 2600		a *	1
	HE Shell M63	BD M58	1.61	2600b	.87	.87	6
	AP Shot M80	Tracer	1.66	1230 to 2780b	.78	1.00*	AP M80
	APC Shot M59	Tracer	1.91	1380 to 3070b	.900	1.00*	APC M59
	APC Shot M51B1 & B2	Tracer	1.92	2900b	.984	.92	6
	TP Shot M51A2	Tracer	1.92	2900b	.984	.92	6
	TP Shot M51A1	Tracer	1.92	2900b	.476	1.90e	1

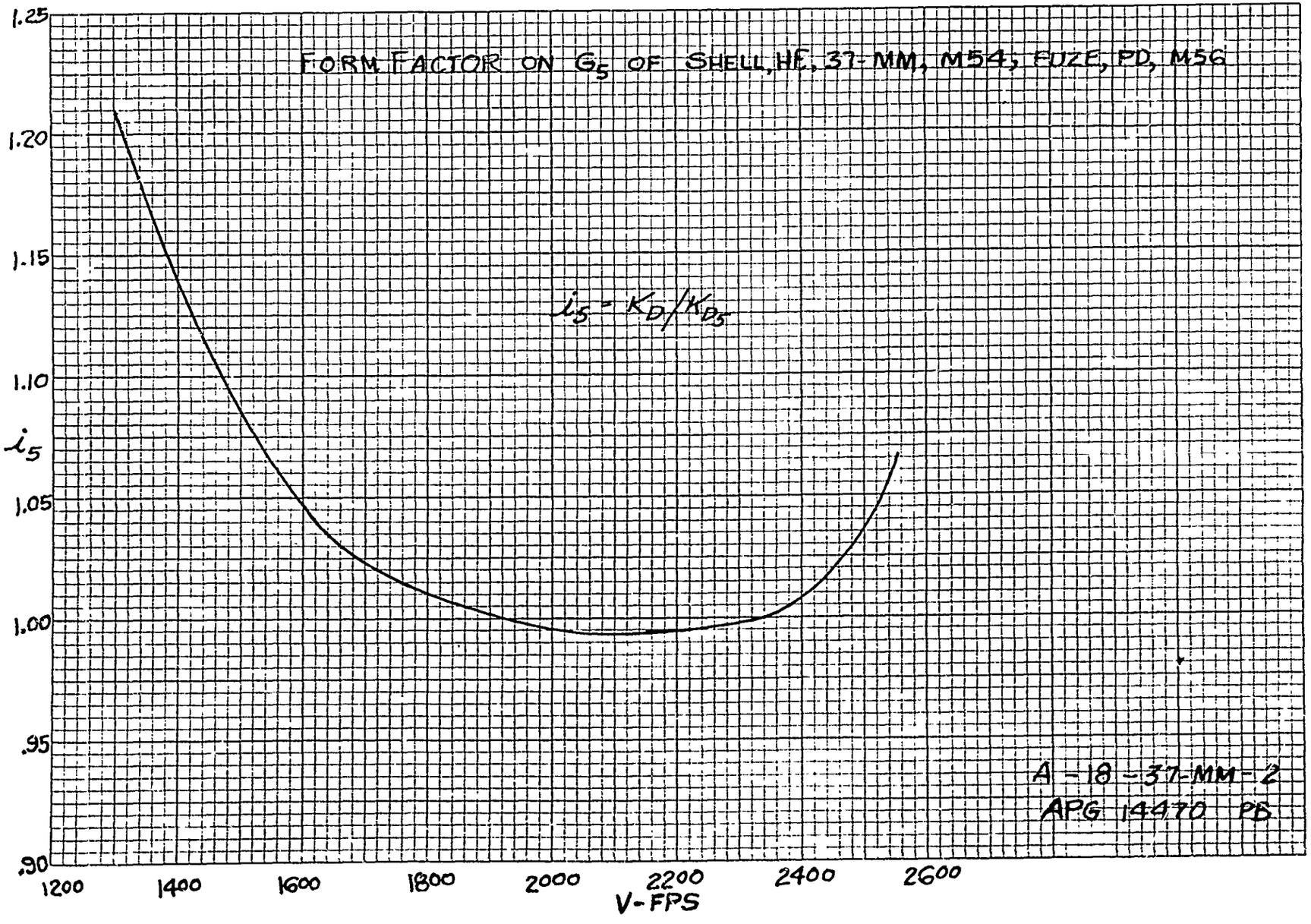
a $i = 0.722 + 0.000{,}56\ v$ (fps)

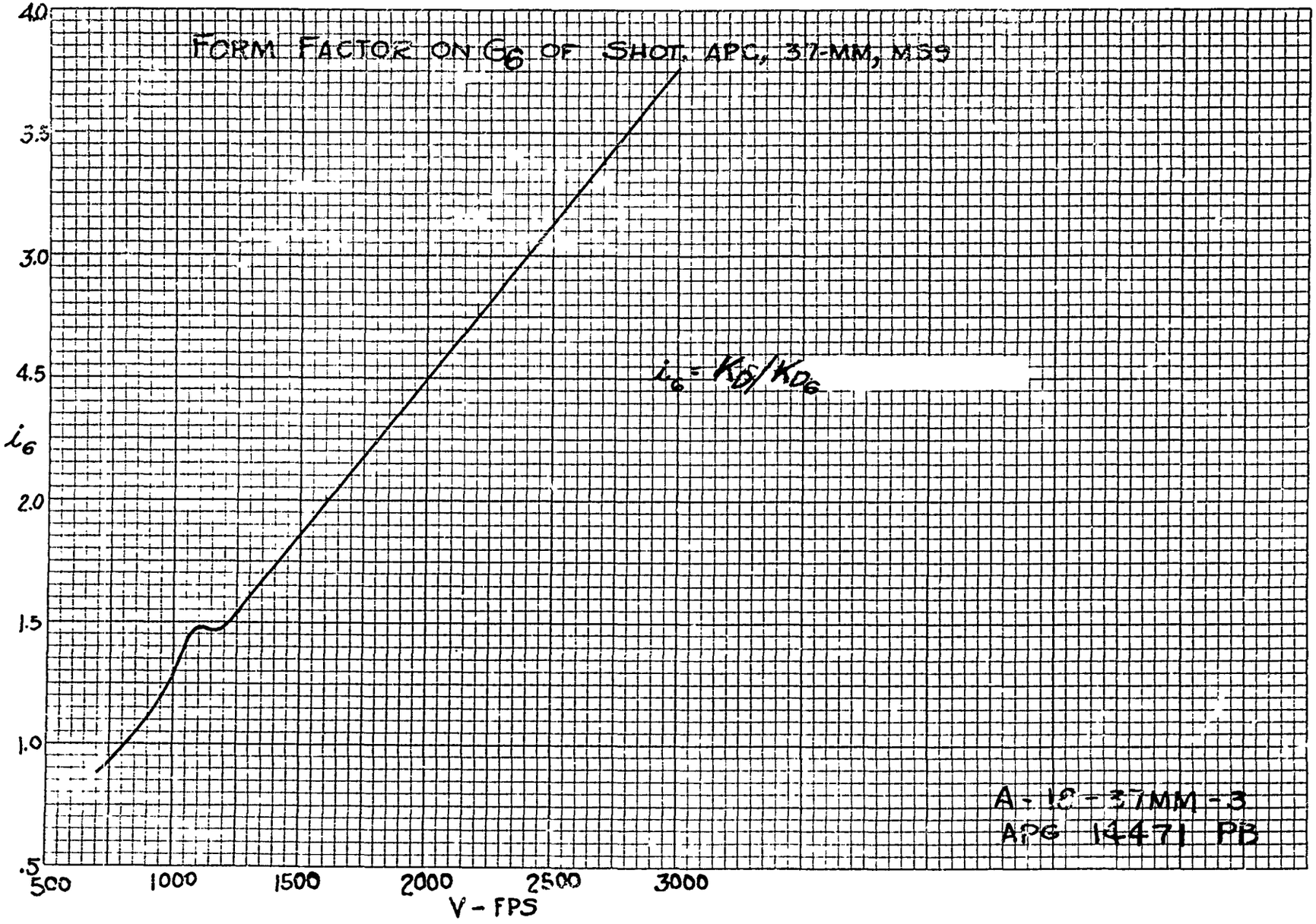
b Standard muzzle Velocities:

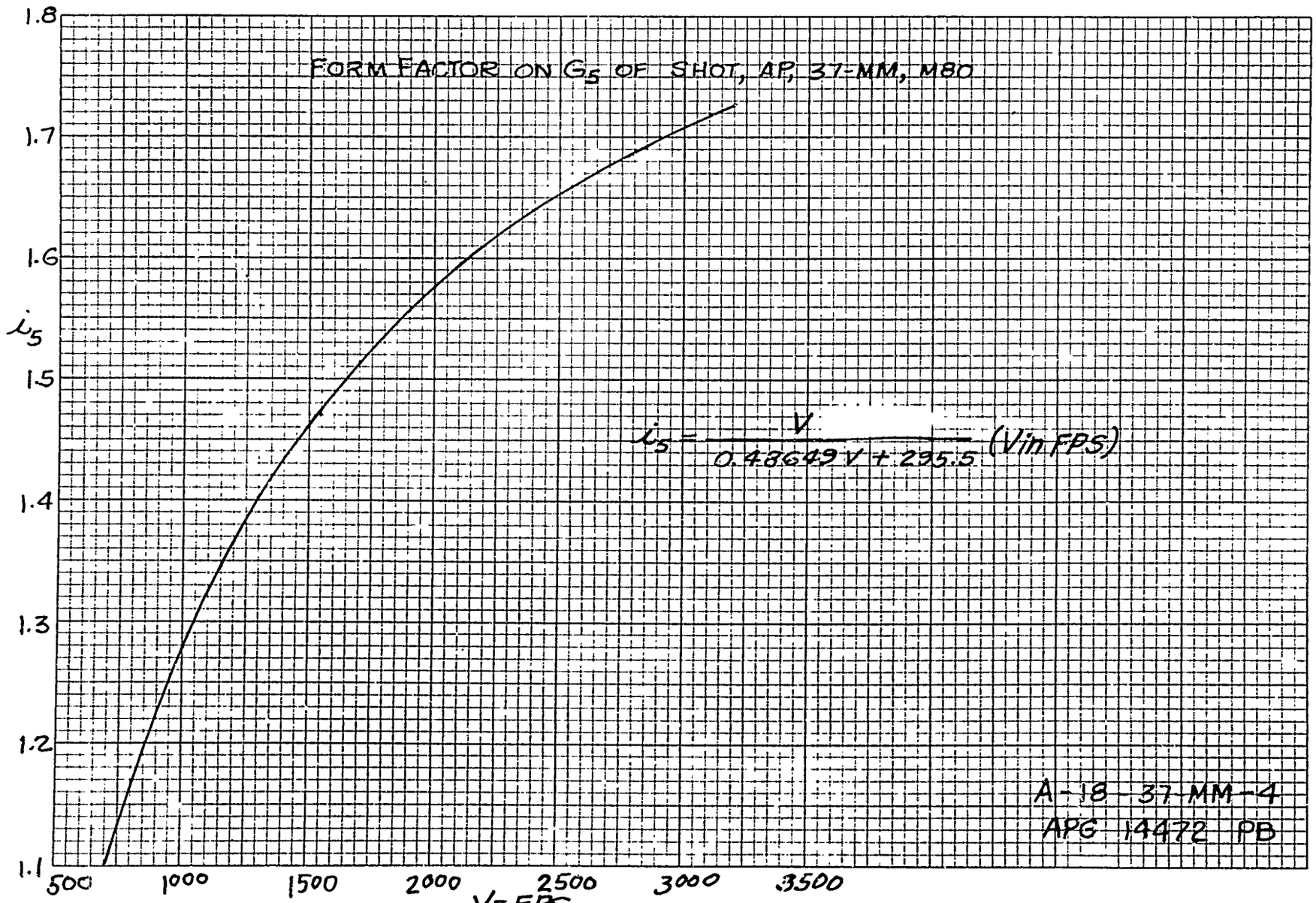
e Estimated

* Determined by resistance firings

Gun	Projectile Mk 2 M 92	M54 M55A1	M63	M59	M51
M1916	1276				
M1A2		2600		2050	
M6			2600		2900


FORM FACTOR ON G_5 OF SHELL, HE, 37-MM, M54; FUZE, PD, M56
$i_5 = K_D / K_{D_5}$
i_5
1.25
1.20
1.15
1.10
1.05
1.00
.95
.90
1200
1400
1600
1800
2000
2200
2400
2600
V-FPS
A-18-37-MM-2
APG 14470 PB


FORM FACTOR ON G_6 OF SHOT, APC, 37-MM, M59
$i_6 = K_{D5}/K_{D6}$
i_6
4.0
3.5
3.0
4.5
2.0
1.5
1.0
.5
500
1000
1500
2000
2500
3000
V - FPS
A-IC-37MM-3
APG 14471 PB


FORM FACTOR ON G_5 OF SHOT, AP, 37-MM, M80
$i_5 = \frac{V}{0.48649\,V + 295.5}$ (V in FPS)
A-18-37-MM-4
APG 14472 PB
i_5
V=FPS
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
500
1000
1500
2000
2500
3000
3500

Form Factors of Projectiles

Gun	Projectile	Fuze	Weight lb.	Velocity fps	Ball. Coef.	Form Factor	Proj. Type
40mm (1.575") Automatic (Antiaircraft) Gun M1	AP Shot M81	Tracer	1.96	2870	.615	1.285	6
	Same w/o cap or windshield					1.10e	1
	APC Shot T4E10	Tracer	1.975	2709	.664	1.20*	6
	HE Shell Mk 2	PD M64A1	1.954	2867	.828	.952	5
		Det. Mk 27	1.954	2896	.850	.927	5
	Same w/o Tracer	Dummy Mk 27		1120 to 2800		1.00*	HE Mk2
	HE Shell T7	Det. Mk 27	1.96	2870	.670	1.18	5
	Practice Shell M91	Dummy T34	1.96	2870	.739	1.07*	5
		Plug 75-14-309B	1.96	2870	.395	2.0e	1
57mm (2.244") Rifle M18	HE Shell M306A1	PD M89, M503	2.75	1200	.608	.90	1
	WP Smoke Shell M308A1	PD M89, M503	2.75	1200	.608	.90	1
	HEAT Shell M307	PI M90	2.75	1200	.52	1.05	1
	Test Projectile T36		3.50		.56	1.24e	2

e Estimated
* Determined by resistance firings

Form Factors of Projectiles

Gun	Projectile	Fuze	Weight lb.	Velocity fps	Ball. Coef.	Form Factor	Proj. Type
60mm (2.362") Mortars M2 and M19	HE Shell M49A2	PD M52	2.96	189	.850	.62	1
	Practice Shell M50A2			292	.730	.73	1
				377	.680	.78	1
				449	.658	.81	1
				518	.650	.82	1
		Hex plug	2.96		.265	2.00e	1
	WP Smoke Shell M302	PD M82	3.98	156	.788	.905	1
				244	.788	.905	1
				316	.788	.905	1
				380	.788	.905	1
				439	.788	.905	1
	Illuminating Shell M83A1	Time M65	3.70	315	.343	2.01	1
				377	.327	2.11	1
				430	.326	2.12	1
	Training Shell M69		4.40	152.5	.39	2.00e	1
	Proof Proj. T1		2.51		.187	2.40e	1

e Estimated

Form Factors of Projectiles

Gun	Projectile	Fuze	Weight lb.	Velocity fps	Ball. Coef.	Form Factor	Proj. Type
75mm (2.953") Tank Guns M3, M6 and M17	AP Shot M72	Tracer	13.94	2030	1.13	1.41*	5
	AP Shot T148		13.36	2120	1.40	1.09	2
	APC Proj. M61A1	BD M66A1	14.90	2030	1.735	.985*	6
	HVAP Shot T45	Tracer	8.31	2940	.87	1.10*	6
	HE Shell Mk 1	PD M46	12.24	1135	1.69	.83	1
				1814	1.53	.92	1
	HE Shell M48	PD M48A2, A3 PD M51A4, A5 PD M81, M81A1 TSQ M54, M55A3 MTSQ M500, M501	14.70	960 1520 1980	1.630 1.705 1.612	1.03 .99 1.05	2 2 2
		CP M78, M78A1	15.47	1855	1.28	1.39*	2
	WP Smoke Shell M64	PD M57	15.25		Same as HE Shell M48		
	BE HC Smoke Shell M89		6.61	850	.323	2.35	1
	HEAT Shell T47E1,2,3	PI T168E1				1.18e	2
	HEP Shell T165E1	BD M62A1, M91	7.74	1773	.726	1.22	1
	HEP Shell T165E2	BD M62A1, M91	9.07	1850	1.134	.92	1
	HEP Shell T165E6	BD M62A1, M91	8.1	1856	.999	.93	1
	HEP Shell T165E10	BD M62A1, M91	8.8	1770	.691	1.46	1
	HEP Shell T165E11	BD M62A1, M91				.92e	1
	HEP Shell T165E12	BD M62A1, M91	8.8	1790	1.012	1.00	1
	HEP Shell T165E14	BD M62A1, M91	10.5	1812	1.179	1.02	1
Antiaircraft Gun T6	HE Shell M48	TSQ M54 MTSQ M501	14.70	1850	1.56	1.08	2
	APC Proj. M61A1	BD M66A1	14.90	1920	1.735	.985*	6
	AP Shot M72	Tracer	13.94	1930	1.13	1.41*	5

e Estimated.
* Determined by resistance firings

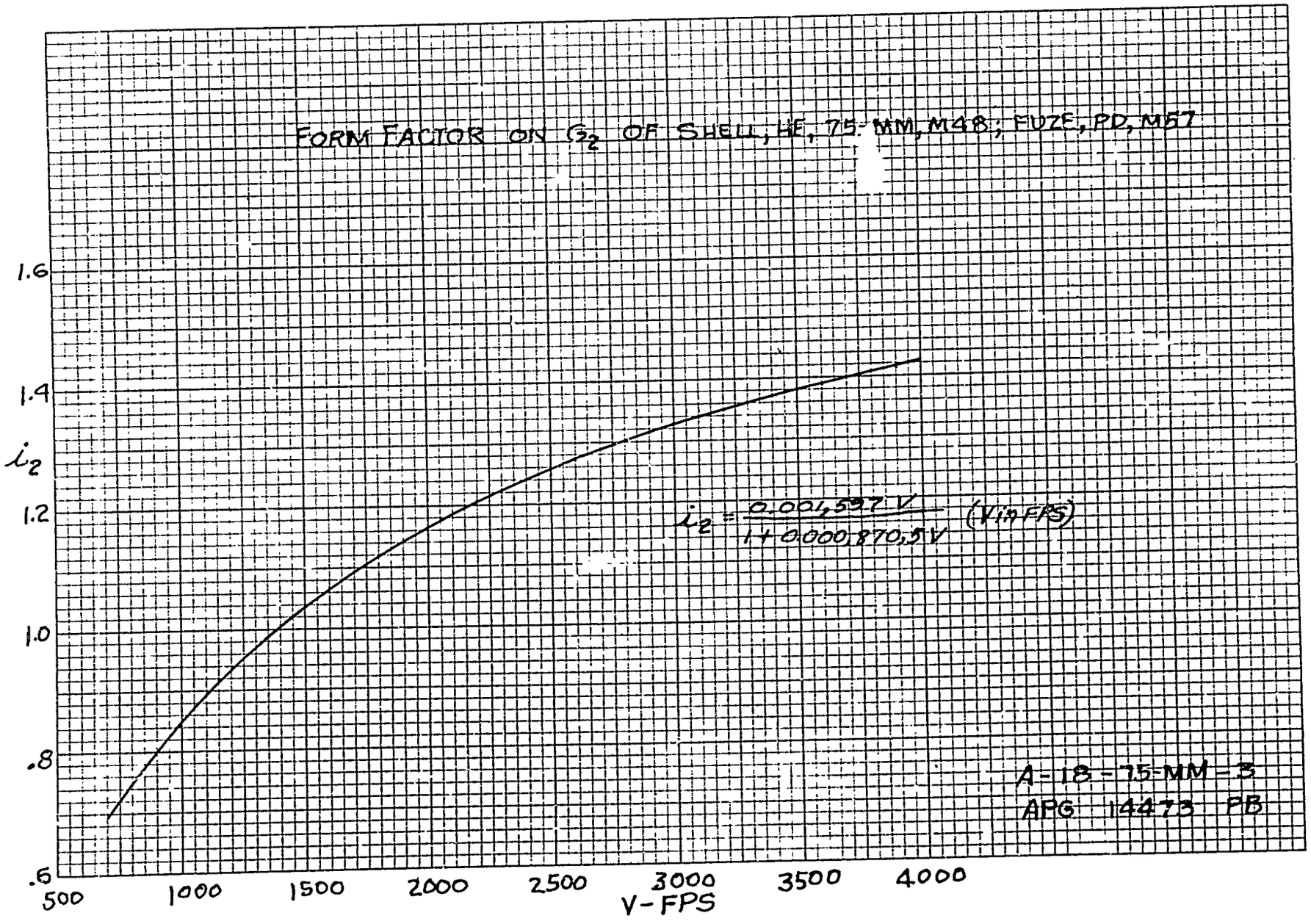
Form Factors of Projectiles

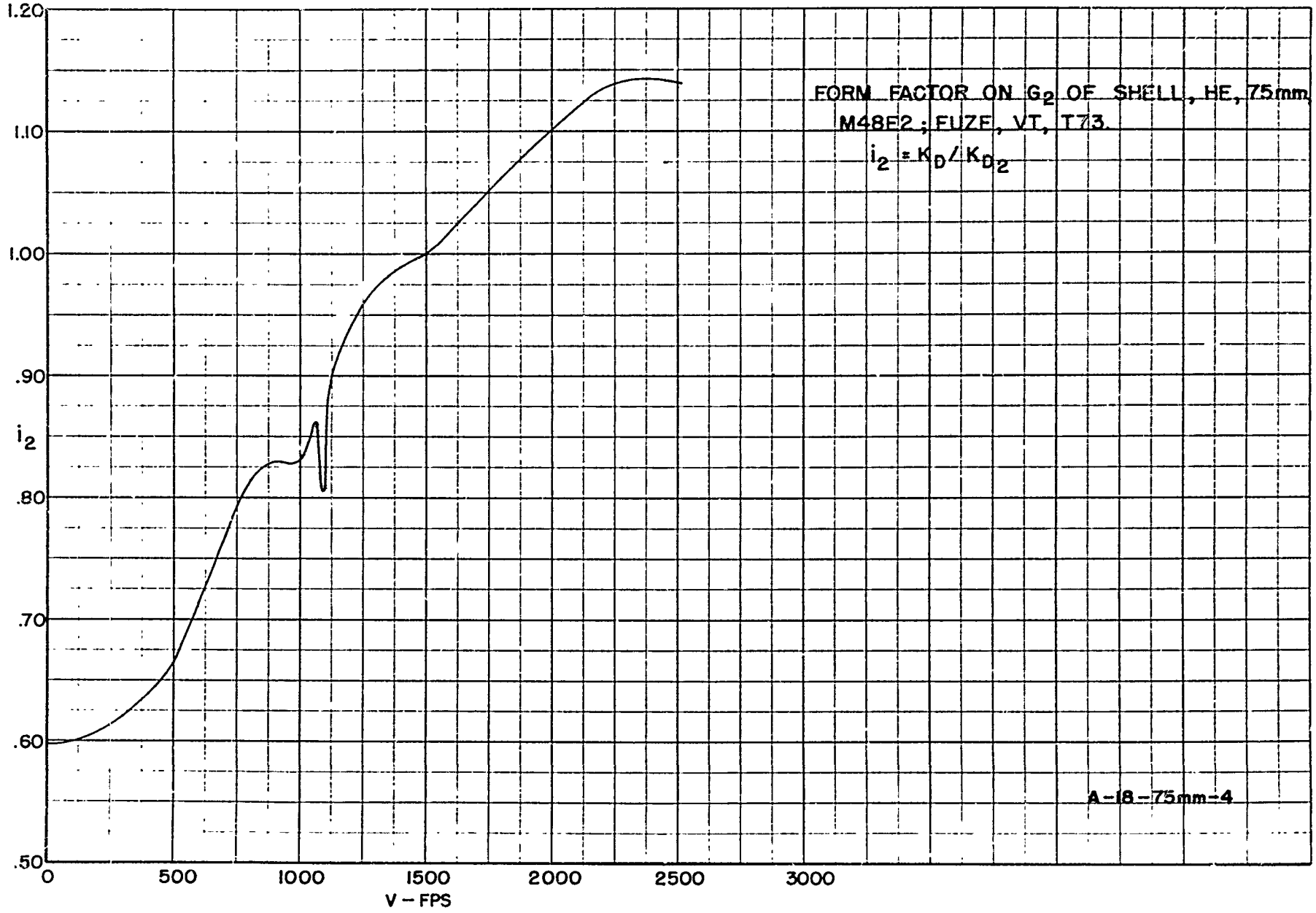
Gun	Projectile	Fuze	Weight lb.	Velocity fps	Ball. Coef.	Form Factor	Proj. Type
75mm (2.953") AA Gun T22	HE Shell M48E2	VT T73	14.95	2300	1.715	1.00	HE M48E2
AA Gun T83E1	HE Shell T50	MTSQ M502	12.15	2825	1.255	1.11	HE M48E2
Sub-caliber Guns M7, M8 M9, M12 and M25	HE Shell M48	PD M48A2, A3 PD M81, M81A1 TSQ M54, M55A3 MTSQ M500, M501	14.70	1470	1.76	.96	2
Howitzer M3	HE Shell M48A1	PD M48A2, A3	13.90	705	1.964	.81	2
		PD M81, M81A1		820	1.886	.85	2
				965	1.830	.87	2
				1270	1.714	.93	2
	HE Shell M48	PD M48A2, A3		700	1.927	.875	2
		PD M81, M81A1	14.70	810	1.883	.895	2
		TSQ M54, M55A3		950	1.888	.89	2
		MTSQ M500, M501		1250	1.869	.90	2
		VT M97					
	Gas and Smoke Shell M64	PD M57	14.94 HS 15.25 WP 15.41 FS			Same as HE Shell M48	
		Plug 75-14-309F				1.40e	5
	HEAT Shell M66	BD M62A1, M91	13.17	1000	1.54	.98*	2
	HEP Shell T150E1	BD M62A1, M91	7.22	1000	0.484	1.71	1
	HEP Shell T150E2	BD M62A1, M91	7.6	1040	1.029	.85	1
	HEP Shell T150E16	BD M62A1, M91	8.85	1013	1.273	.80	1

e Estimated
* Determined by resistance firings

Form Factors of Projectiles

Gun	Projectile	Fuze	Weight lb.	Velocity fps	Ball. Coef.	Form Factor	Proj. Type
75mm (2.953") Rifle M20	HE Shell M309, M309A1	PD M48A2, A3 PD M81, M81A1 PD M51A4, A5 MTSQ M500, M501	14.40	990	1.473	1.12	2
	HEAT Shell M310, M310A1	BD M62A1, M91	13.10	1000	1.781	.84	6
	WP Smoke Shell M311, M311A1	PD M84A2, A3 PD M81, M81A1 PD M51A4, A5	14.82	990	1.516	1.12	2
		PD M57	15.10	990	1.545	1.12	2
	HEP Shell T151E1	BD M62A1, M91	6.8	1137	.566	1.38	1
	HEP Shell T151E4	BD M62A1, M91	8.04	1050	1.302	.71	1
	HEP Shell T151E4A	BD M62A1, M91	8.347	1058	1.308	.73	1
	HEP Shell T151E11	BD M62A1, M91	8.50	1026	1.343	.73	1
	HEP Shell T151E11D	BD M62A1, M91	8.478	1390	1.092	.89	1
	HEP Shell T151E16	BD M62A1, M91	8.66	1064	1.268	.78	1
	HEP Shell T151E17	BD M62A1, M91	8.64	1064	1.300	.76	1


FORM FACTOR ON C_2 OF SHELL, HE, 75-MM, M48; FUZE, PD, M57
i_2
1.6
1.4
1.2
1.0
.8
.6
500
1000
1500
2000
2500
3000
3500
4000
V-FPS
$i_2 = \frac{0.001,597\,V}{1 + 0.000,870,5\,V}$ (V in FPS)
A-18-75-MM-3
APG 14473 PB


FORM FACTOR ON G_2 OF SHELL, HE, 75mm, M48E2; FUZE, VT, T73.
$i_2 = K_D / K_{D_2}$
A-18-75mm-4
1.20
1.10
1.00
.90
.80
.70
.60
.50
i_2
0
500
1000
1500
2000
2500
3000
V - FPS

Form Factors of Projectiles

Gun	Projectile	Fuze	Weight lb.	Velocity fps	Ball. Coef.	Form Factor	Proj. Type
76mm (3.000") Tank Guns M1A2 T91 T12A	AP Shot M79	Tracer	15.00	2600	1.59	1.05*	1
	AP Shot T128E6		14.58	3200	1.392	1.16	8
	APC Proj. M62A1	BD M66A1	15.40	2600	1.714	1.00	6
	HVAP Shot M93	Tracer	9.31	3400	0.888	1.165	8
	HVAP Shot M321 (T29E15)		6.90	3775	0.576	1.33	8
	HVAP (DS) Shot M331 (T145)		6.16	3862	1.582	.93a	8
	HVAP Shot T66		7.00	4135	0.625	1.24	8
	HVAP Shot T66E1		6.83	3990	0.598	1.27	8
	HVTP Shot M315 (T24E1)	Tracer	9.31	3400	0.903	1.145	8
	HVTP Shot T73	Tracer	6.67	3755	0.652	1.14	8
			6.66	3841	0.646	1.15	8
	HVTP Shot T74		7.00	4135	0.625	1.24e	8
	HE Shell M42A1	PD M48A2, A3					
		PD M51A4, A5		2700	1.226	1.16	2
		PD M81, M81A1	12.80	1550	1.357	1.05	6
		TSQ M54, M55A3					
		MTSQ M500, M501					
		CP M78, M78A1	13.14	1539	1.294	1.10	6
				2680	1.066	1.37*	6
	HE Shell T18	Dummy T144	15		1.755	.95e	6
	HE Shell T20	Dummy M73				1.34e	8
		Dummy T144				.95e	6
	HE Shell T64	Dummy M73	14.7	2400	1.60	1.02	2
	HE Shell T80E1	Dummy M73	14.63	2430	1.355	1.20	2
	WP Smoke Shell M312	PD M57	12.95			Same as HE Shell M42A1	
	Smoke Shell M88		7.60	900	0.485	1.74e	1
	HEP Shell T165E1	BD M62A1, M91	7.74	1850	0.703	1.22	1
	HEP Shell T169E1	BD M62A1, M91	9.36	2340	1.022	1.02	1
	Illuminating Proj. Mk 25	TSQ M54	13.00	2450	1.378	1.05	6
	Proof Proj. T30E1			1200		1.726	1
				1600		1.795	1
				2000		1.865	1
				2400		1.934	1
				2800		2.004	1
				3200		2.053	1

a The diameter of the shot is 2.047 in. (52mm)
e Estimated
* Determined by resistance firings

Form Factors of Projectiles

Gun	Projectile	Fuze	Weight lb.	Velocity fps	Ball. Coef.	Form Factor	Proj. Type
81mm (3.189") Mortars M1, M2, M19, M21 and M29	HE Shell M43A1	PD M52, M52A1	6.87	235	1.230	.55	1
	Practice Shell M43A1			332	.984	.69	1
	Practice Shell M44			419	.861	.78	1
				499	.944	.72	1
				572	.906	.75	1
				638	.881	.77	1
				700	.802	.84	1
		TSQ M77	7.96	320	1.173	.67	1
				403	1.019	.77	1
				476	1.062	.74	1
				542	1.065	.73	1
				603	1.033	.76	1
				660	.985	.79	1
	HE Shell M56	PD M53A1	10.62	306	.947	1.10	1
				412	.916	1.14	1
				502	.900	1.16	1
				583	.850	1.23	1
		TSQ M77	11.62	300	1.036	1.10	1
				399	1.005	1.14	1
				482	.987	1.16	1
				557	.946	1.21	1
	HE Shell T28E6	TSQ M77		755		.84a	1

a Approximate

Form Factors of Projectiles

Gun	Projectile	Fuze	Weight lbs.	Velocity fps	Ball. Coef.	Form Factor	Proj. Type
81mm (3.189") Mortars M1, M2, M19, M21 and M29	Smoke Shell M57 (WP)	PD M52, M52A1	11.36	297	1.012	1.10	1
				399	.986	1.13	1
				484	.965	1.16	1
				560	.955	1.17	1
		TSQ M77	12.45	284	1.101	1.11	1
				381	1.078	1.14	1
				462	1.056	1.16	1
				535	1.042	1.17	1
	Smoke Shell M57 (FS)	PD M52 M52A1	11.86	291	1.144	1.02	1
				390	1.131	1.03	1
				472	1.083	1.08	1
				544	1.010	1.15	1
	Illuminating Shell M301	Time M84	10.49	423	1.124	.92	1
				516	1.055	.98	1
				597	.995	1.04	1
	Training Shell M68		10.75	172.8	.53	2.00e	1
	Proof Proj. T5		5.97		.245	2.40e	1

e Estimated

Form Factors of Projectiles

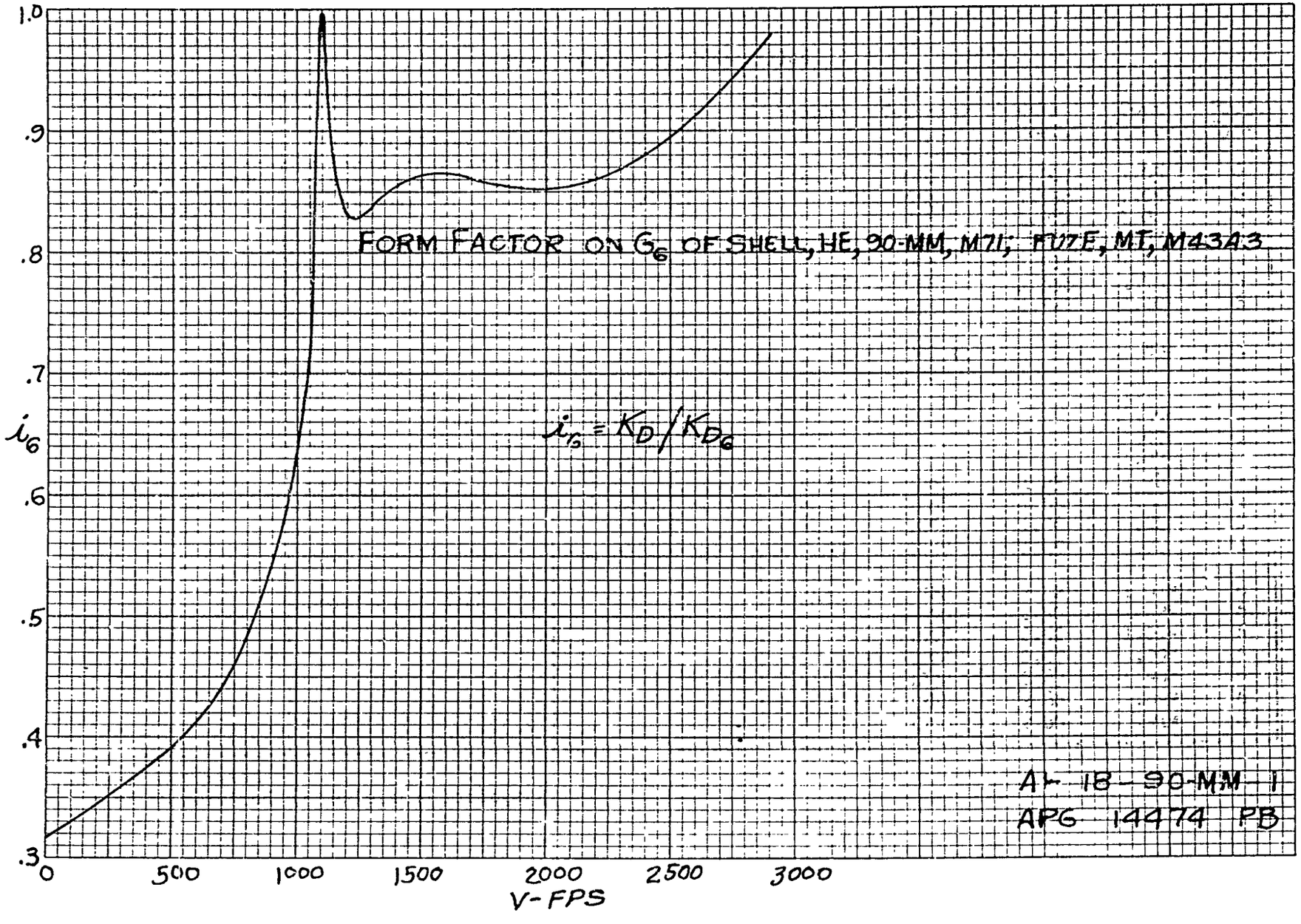
Gun	Projectile	Fuze	Weight lbs.	Velocity fps	Ball. Coef.	Form Factor	Proj. Type
90mm (3.543") Guns M1, M1A1, M1A2, M1A3, M2, M2A1, M2A2, M3, M3A1, M3A2, M26, T8, T119, T125, and T139	AP Shot M77	Tracer	23.40	2700	1.564	1.19*	1
	AP Shot M318	Tracer	24.06	2666	1.90	1.01*	6
	AP Shot T54	Tracer				1.01e	6
	APC Proj. M82	BD M68	24.11	2670	2.134	.90*	6
				2800	2.163	.89	6
	APC Proj. T50E1	BD M68				.90e	6
	HVAP Shot M304	Tracer	16.80	3350	1.15	1.16*	8
	HVAP Shot M332 (T67E7)	Tracer	12.20	3900	.810	1.20	8
	HVAP Shot M332B1 (T67E6)		12.44	4100	.826		
	HVTP Shot M333 (T83)						
	HVTP Shot M317 (T45)	Tracer	16.80	3257	1.155	1.16*	8
	HVAP Shot T65E4		10.0	3529	2.117	.89a	1
	HVAP Shot T65E9		10.4	3518	2.608	.75a	1
	HE Shell M58 and M58B1	MT M43A5, MTSQ M502	21.00	2800	1.66	1.01	2
		Plug 75-14-309E	23.40	2628	.79	2.35*	5
	HE Shell M71	MT M43A5, M67A3, MTSQ M502, VT M92, M93	23.40	2700	1.864	1.00	HE M71
		PD M48A2, A3, PD M51A4, A5, PD M81, M81A1, TSQ M54, M55A3, MTSQ M500, M501, VT M97A1	23.40	2700b	1.79	1.04	2
		CP M78, M78A1	23.74	2673	1.596	1.89	2
		Plug 75-14-309E	23.40		.79	2.35e	5
	WP Smoke Shell M313	PD M57	23.40	2700	1.79	1.04	2

a The diameter of the shot is 2.3 in.
b For the T119 Gun, the MV is 2765 fps
e Estimated
* Determined by resistance firings

Form Factors of Projectiles

Gun	Projectile	Fuze	Weight lb.	Velocity fps	Ball. Coef.	Form Factor	Proj. Type
90mm (3.543") Guns M1, M1A1, M1A2, M1A3, M2, M2A1, M2A2, M3, M3A1, M3A2, M26, T8, T119, T125, and T139	HE Shell T91 WP Smoke Shell T92	PD M48A2, A3	18.00	2100 to 2400b	1.43	1.00e	2
	HE (DS) Shell T82E1, E2, E5 and E10	PD T194	11.5	2000	3.31	1.40ae	2
				3000	3.05	1.52ae	2
				4000	2.79	1.66ae	2
				5000	2.45	1.89ae	2
	HE (DS) Shell T82E19	PD T194	16.25	2000	2.67	2.45ae	1
				3000	2.28	2.87ae	1
				4000	2.20	2.98ae	1
	HEAT Shell T108E1	PI T209	14.3	2446	.550	2.07	2
	HEAT Shell T108E3	PI T209	14.2	2400	1.79	0.63	1
	HEAT Shell T108E11 E15, E19 and E20	PI T209	14.2	2400to 2800	1.79	0.63e	1
	HEP Shell T142E1	BD M62A1, M91	17.7	1950	.943	1.495	1
	HEP Shell T142E2	BD M62A1, M91	16.8	1950	1.580	.85	1
Tank Guns T15, T15E1, T15E2 and T15E3	AP Shot M318	Tracer	24.06	3029	1.81	1.06*	7
	APC Proj. M82	BD M68	24.11	3017	1.83	1.05*	7
	HVAP Shot T30E15	Tracer	16.62	3316	1.08	1.23*	7
				3671	1.03	1.28*	7
	HVAP Shot T44	Tracer	16.78	3700	1.016	1.32*	8
	HVAP Shot T44E2	Tracer				1.32e	8

a The diameter of the shot is 1.575 in. (40mm)
b The T91 and T92 Shell must be fired from only the T119 Gun
e Estimated
* Determined from resistance firings


FORM FACTOR ON G_6 OF SHELL, HE, 90-MM, M71; FUZE, MT, M43A3
$i_{G_6} = K_D / K_{D_6}$
i_{G_6}
1.0
.9
.8
.7
.6
.5
.4
.3
0
500
1000
1500
2000
2500
3000
V-FPS
AI-18-90-MM-1
APG 14474 PB

Form Factors of Projectiles

Gun	Projectile	Fuze	Weight lb.	Velocity fps	Ball. Coef.	Form Factor	Proj. Type
105mm (4.134") Rifle M27	HE Shell M323 (T42)	PD M51A4, A5 PD M81, M81A1 MTSQ M500, M501	32.4	1120	2.23	.85	2
	HEAT Shell 324 (T43)	BD M91	29.3	1250	1.34	1.28	2
	WP Smoke Shell M325 (T44)	PD M51A4, A5 PD M81, M81A1 MTSQ M500, M501	34.6	1120	2.38	.85	2
	HEP Shell M326 (T139E2)	BD M91	24.8	1328 1768	1.74 1.65	.835 .88	1 1
Aircraft Gun T7	HE Shell M1	PD M48	33.0	425 to 3000	1.931	1.00	HE M1
Tank Guns T5E1 and T5E2	APC Shot T32E1, E2		39.0	2841	2.22	1.03	8
	HVAP Shot T29E4	Tracer	24.6	3358	1.29	1.12	8
	HE Shell T30E1	PD M51A4, A5 PD M81, M81A1 MTSQ M500, M501	33.5	2266 2930	2.00 1.88	.98 1.04	8 8
		CP M78, M78A1	34.22	2252	1.83	1.095	8

Form Factors of Projectiles

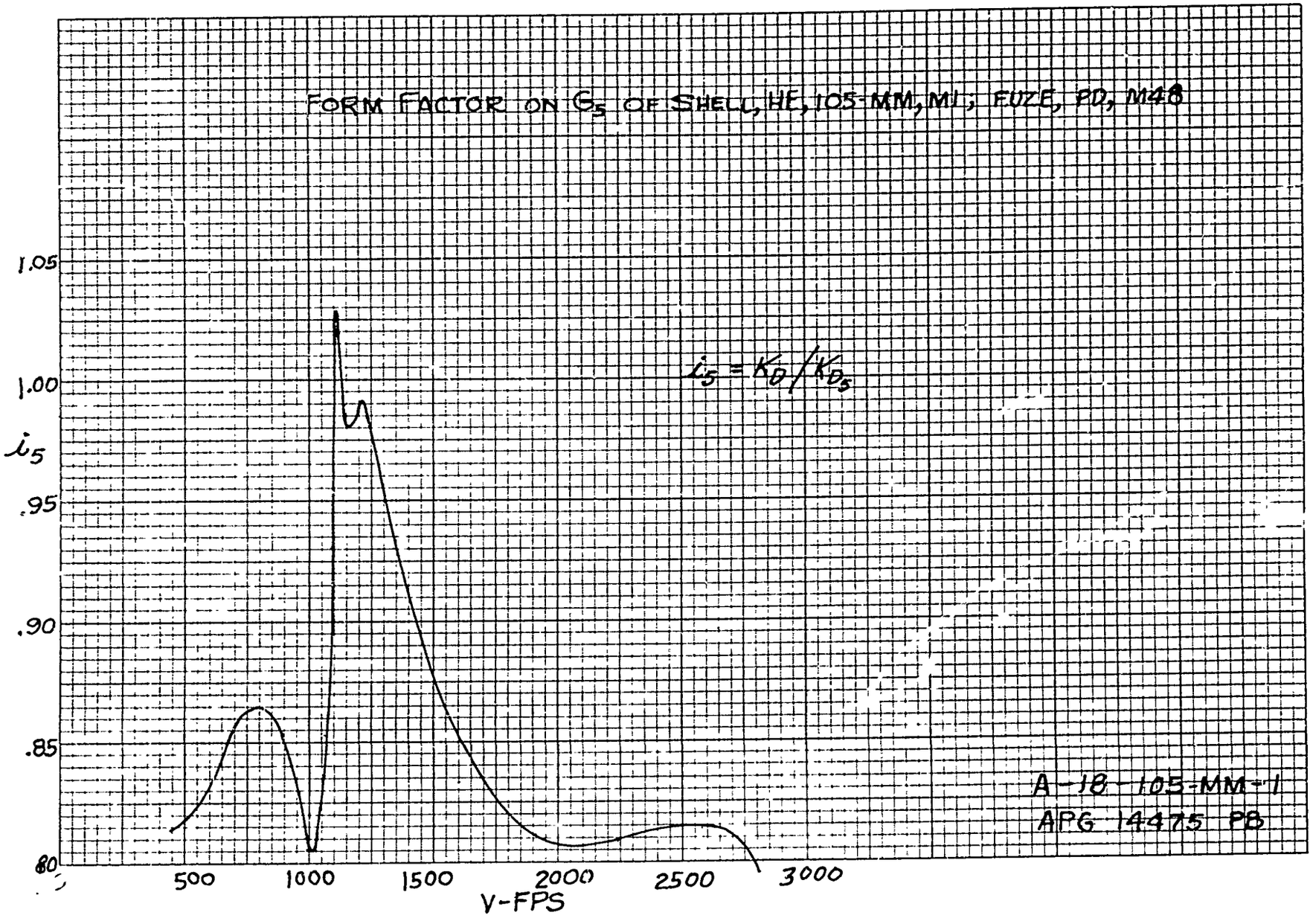
Gun	Projectile	Fuze	Weight lb.	Velocity fps	Ball. Coef.	Form Factor	Proj. Type
105mm (4.134") Howitzers M2A1 and M4	Illuminating Shell M314	TSQ M54 / MTSQ M501	36.60	620	2.007	1.05	6
				674	1.996	1.055	6
				738	1.981	1.06	6
				825	1.959	1.075	6
				958	1.914	1.10	6
				1158	1.856	1.13	6
				1453	1.920	1.10	6
	HEP Shell T81E1	BD M62A1, M91		900 to 1500		.83e	1
	HEP Shell T81E2, E3	BD M62A1, M91				1.71e	1
	HEP Shell T81E4	BD M62A1, M91				1.39e	1
	HEP Shell T81E5, E6	BD M62A1, M91				1.07e	1
	HEP Shell T81E8, E9	BD M62A1, M91				1.07e	1
	HEP Shell T81E16	BD M62A1, M91	26.6	1760	1.253	1.24	1
	HEP Shell T81E17	BD M62A1, M91	25.3	1768	1.68	.88	1
				1250	1.76	.84	1
	HEP Shell T81E18B	BD M62A1, M91	23.17	2037	1.45	.94	1
	Model Shell T124		43.5	784	2.52	1.01*	6
				896	2.50	1.02*	6
				1008	2.52	1.01*	6
				1120	2.57	.99*	6
				1232	2.83	.90*	6
				1344	2.86	.89*	6
				1456	2.80	.91*	6

e Estimated
* Determined by resistance firings

Form Factors of Projectiles

Gun	Projectile	Fuze	Weight lb.	Velocity fps	Ball. Coef.	Form Factor	Proj. Type
105mm (4.134") Howitzers M2A1 and M4	HE Shell M1	PD M48A2, A3	33.00	650	2.572	.75	2
		PD M51A4, A5		710	2.489	.78	2
		PD M81, M81A1		780	2.392	.81	2
		TSQ M54, M55A3		875	2.260	.85	2
		MTSQ M500, M501		1020	2.311	.84	2
		VT M97A1		1235	2.230	.87	2
				1550	1.994	.97	2
		CP M78, M78A1	33.60	1519	2.12	.93*	5
		Plug 75-14-309E	33.00		1.76	1.10e	5
	Smoke Shell M60	PD M57	33.38 HS			Same as HE Shell M1 with PD Fuze	
		PD M51A5	34.31 WP				
			34.82 FS				
	BE Smoke Shell M84	TSQ M54	32.87 HC			Same as HE Shell M1 with TSQ Fuze	
		MTSQ M500	30.50 Green				
		MTSQ M501	30.50 Violet				
			30.70 Red				
			30.30 Yellow				
	HEAT Shell M67	BD M62	29.29	1020	1.62	1.06*	2
				1250	1.62	1.06*	2
		BD M91	29.23	1250	1.64	1.04*	2
	TP Shell M67	Dummy T121	29.00	1239	1.62	1.05*	2
				1674	1.26	.78	1
	HEAT Shell T118E13	PI T209	16.8	1729	1.40	.70	1
	HEAT Shell T131E6	PI T209	25.11	1549	1.98	.74	1
	HEAT Shell T131E31	PI T209	23.03	1940	1.80	.75	1
	HE Shell T185	PD T155 Mod. Dummy T144E1	29.4	1680	2.13	.81	2

e Estimated
* Determined by resistance firing


FORM FACTOR ON G_5 OF SHELL, HE, 105-MM, M1; FUZE, PD, M48
$i_5 = K_D / K_{D_5}$
1.05
1.00
i_5
.95
.90
.85
.80
500
1000
1500
2000
2500
3000
V-FPS
A-18-105-MM-1
APG 14475 PB

Form Factors of Projectiles

Gun	Projectile	Fuze	Weight lb.	Velocity fps	Ball. Coef.	Form Factor	Proj. Type
4.2" (106.7mm) Chemical Mortars M2 and M3C	HE Shell M3	PD M3, M4 PD M9 PD M2, M8	24.25	239	1.216	1.13	1
				360	1.205	1.14	1
	Gas and Smoke Shell M2 (CG, H, HD, CNB, CK, HT, PWP)		(Varies with filler)	459	1.187	1.16	1
				546	1.158	1.19	1
				625	1.115	1.23	1
				694	1.065	1.29	1
				757	1.009	1.36	1
				814	0.952	1.44	1
				841	0.922	1.49	1
	Gas and Smoke Shell M2 (FS, WP, FM, CNS)	PD M2, M8	25.50 (Varies with filler)	219	1.216	1.19	1
				343	1.205	1.20	1
				446	1.187	1.22	1
				533	1.158	1.25	1
				613	1.115	1.30	1
				682	1.065	1.36	1
				743	1.009	1.43	1
				796	0.952	1.52	1
				820	0.922	1.57	1
Recoilless Chemical Mortar M4	HE Shell M6	PD E48R1 PD M2, M3, M4 PD M5, M6 b	24.25	715 730a	1.035	1.33	1
	Smoke Shell E77 (PWP, CG, H) c	PD E48R1 PD M2, M3, M4 PD M5, M6, b	25.25	715 730a	1.035	1.38	1

a MV is 715 fps with Rocket Driver M1, 730 fps without it
b Fuzes M2, M3, M4 and M5 may be used without Rocket Driver
c CG and H are used without Rocket Driver

Form Factors of Projectiles

Gun	Projectile	Fuze	Weight lb.	Velocity fps	Ball. Coef.	Form Factor	Proj. Type
120mm (4.700") Antiaircraft Gun M1, M1A1, M1A2	AE Shell M73	MT M61, M61A1 / VT M50, M50A1	50	3100	2.535	.89	2
		PD M48 series	49.79	3000	1.288	1.75e	5
		Plug 75-14-309E	50	3000	1.92	1.18*	1
Gun T53, T123	HE Shell T15	MT T44	55	3000	3.025	.82	2
	HE Shell T17	MT T44	51.37	3000	2.637	.88	2
	HE Shell T55 / WP Smoke Shell T16	PD M52A5	50	2500	2.76	.82	8
	AP Shot T116	Tracer	50	3150	2.050	1.10	8
	Same w/o windshield	Tracer				1.19e	1
	APC Shot, T14E3	Tracer	50	3150	2.31	.98e	6
	Same w/o windshield	Tracer		3000		1.84e	1
	Same w/o cap or windshield	Tracer				1.40e	1
	HVAP Shot T17E1 Mod. 0	Tracer	28	4150	2.04	.62	1

e Estimated
* Determined by resistance firings

Form Factors of Projectiles

Gun	Projectile	Fuze	Weight lb.	Velocity fps	Ball. Coef.	Form Factor	Proj. Type
155mm (6.102") Howitzer M1	HE Shell M107	PD M51A4, A5 PD M81, M81A1 TSQ M54, M55A3 MTSQ M500, M501 VT M96	95	680	3.315	.77	2
				770	3.178	.80	2
				880	3.010	.85	2
				1020	2.790	.91	2
				1220	2.952	.86	2
				1520	2.837	.90	2
				1850	2.710	.94	2
		CP M78, M78A1	95.34			1% higher than with PD Fuze	
		Plug 75-14-309E	95		2.41	1.06e	5
		Circular Plug				1.12e	5
	Gas or Smoke Shell M110	PD M51A4, A5 PD M81, M81A1	94.20 HS 98.10 WP 99.40 FS			Same as HE Shell M107	
		Plug 75-14-309E	95		2.41	1.06e	5
	Gas or Smoke Shell T77	PD M51A4, A5 PD M81, M81A1	96			Same as HE Shell M107	
	BE Smoke Shell M116, M116B1	TSQ M54 MTSQ M501	95.10 HC, Red Yellow, Green, Violet			Same as HE Shell M107	
	Illuminating Shell M118, M118B1	TSQ M54 MTSQ M501	103.06	650	2.545	1.09	6
				735	2.572	1.08	6
				840	2.575	1.075	6
				970	2.534	1.09	6
				1160	2.385	1.16	6
	AP Proj. M112B2	ED M60	100	1815	3.035	.885*	6

e Estimated
* Determined by resistance firings

Form Factors of Projectiles

Gun	Projectile	Fuze	Weight lb.	Velocity fps	Ball. Coef.	Form Factor	Proj. Type
155mm (6.102") Guns M1, M1-c M1A1, M2, M3 and M4	HE Shell M101	PD M51A4, A5	95	2100	3.19	.80*	5
		PD M81, M81A1		2800	3.07	.83*	5
		TSQ M54, M55A3 MTSQ M500, M501					
		CP M78, M78A1	95.34	2800	2.91	.87e	5
		Plug 75-14-309E	95		2.41	1.06e	5
	HE Shell T5	PD T16	95		2.84	.90e	2
	Gas or Smoke Shell M104	PD M51A4, A5	93.45 HS	2100	3.14	.80	5
		PD M81, M81A1		2800	2.99	.84	5
		MT M67A3	98.37 WP	2100	3.30	.80	5
				2800	3.15	.84	5
			98.63 FS	2100	3.31	.80	5
				2800	3.15	.84	5
		Plug 75-14-309E	98		2.48	1.06e	5
	BE Smoke Shell M117	TSQ M54	94.73 HC	2100	3.22	.79	5
		MTSQ M501		2800	3.10	.82e	5
	Illuminating Shell M118, M118B1	TSQ M54 MTSQ M501	103.06	2000	2.337	1.185	6
	AP Proj. M112	BD M60	100	2341	2.95	.91*	6
	M112B2			2745	3.000	.895	6
	AP Proj. T27E1					Same as M112	
	AP Proj. T9		98		2.83	.93e	6
	Same w/o windshield					1.10e	1
Gun M2E1	HE Shell T45E1	PD M51A4	95	2800	2.507	1.02	2
	HE Shell T45E3, E4, E5	PD M51A4	95	2800	2.507	1.02e	2

e Estimated
* Determined by resistance firings

Form Factors of Projectiles

Gun	Projectile	Fuze	Weight lb.	Velocity fps	Ball. Coef.	Form Factors	Proj. Type
8"(203.2mm) Howitzer M2	HE Shell M106	PD M51A4, A5	200	820	3.50	.89	5
		PD M81, M81A1		900	3.44	.91	5
		MT M67A3		1000	3.39	.92	5
		TSQ M54, M55A3		1150	3.36	.93	5
		MTSQ M500, M501		1380	3.34	.94	5
		VT M96		1640	3.53	.89	5
				1950	3.79	.82	5
		Plug 75-14-309E	200		2.84	1.10e	5
	HE Shell Mk 3A1	PD M51A4, A5	200	795	2.920	1.07	6
		PD M81, M81A1		873	2.920	1.07	6
		TSQ M54, M55A3		970	2.920	1.07	6
		MTSQ M500, M501		1115	2.950	1.06	6
				1339	2.907	1.075	6
				1590	2.860	1.09	6
				1880	2.805	1.11	6
	Proof Proj. T9	Circular plug	200	820	5.90	.53*	1
				1020	5.90	.53e	1
				1380	7.57	.43*	1
Gun M1	HE Shell M103	PD M51A4 Mod. 3	240	2100	4.25	.88	2
		PD M51A5 Mod. 3		2600	4.21	.89	2
		MT M67A3		2840	4.21	.89	2
		MTSQ M500, M501					
		CP M78, M78A1					
	Common Proj. Mk 14	BD Mk 11	260	2750	4.76	.85	6
	Common Proj. Mk 17	BD Mk 12					

e Estimated
* Determined by resistance firings

Form Factors of Projectiles

Gun	Projectile	Fuze	Weight lb.	Velocity fps	Ball. Coef.	Form Factor	Proj. Type
240mm (9.449") Howitzer M1	HE Shell M114	PD M51A4, A5	360	1500	4.31	.94	2
		PD M81, M81A1		1740	4.16	.97	2
		MT M67A3		2020	4.07	.99	2
		MTSQ M500, M501		2300	4.11	.98	2
		VT M96					
		CP M78, M78A1		2300		1.03e	2
		Plug 75-14-309E	360		3.88	1.0he	5
Gun T1	HE Shell T10	PD M51A4, A5	400	2704	4.67	.96	2
		PD M81, M81A1		2798	4.72	.95	2
		MT M67A3		3136	4.77	.94	2
		MTSQ M500, M501					
	Shell T158		380		4.58	.93e	6
250mm (10") Mortar T5E2	HE Shell T3	PD T164E2	250		3.73	.67	1

e Estimated

Form Factors of Projectiles

Gun	Projectile	Fuze	Weight lb.	Velocity fps	Ball. Coef.	Form Factor	Proj. Type
12" Gun M1888, M1888MI, MI½ M1888MII	AP Shell Mk 1	BD Mk X	900	2250	7.90	.80	6
	AP Shot Mk 16	BD Mk X	975	2260	7.38	.91	6
	AP Shot M1912A	BD Mk X	1070	2235	8.10	.92	6
	AP Shot M1913	BD Mk X	1070	2235	8.10	.92	6
Gun M1900	AP Shot Mk 16	BD Mk X	975	2275	7.38	.91	6
	AP Shot M1912A	BD Mk X	1070	2250	8.10	.92	6
	AP Shot M1913	BD Mk X	1070	2250	8.10	.92	6
	TP Proj. M1911		1070	2250	8.10	.92	6
14" Guns M1909 M1910	AP Shot Mk 6	BD Mk X	1560	2350	9.50	.84	6
	TP Proj. Mk 10		1560	2350	9.50	.84	6
	AP Shot Mk 8 M9A1	BD Mk X	1400	2400	6.11	1.17	6
	AP Shot M1909	BD Mk X	1660	2350	7.80	1.09	6
Gun M1920MI M1920MII	AP Shot Mk 6	BD Mk X	1560	2650	8.55	.93	6
	TP Proj. Mk 10		1560	2650	8.55	.93	6
	AP Shot Mk 8 M9A1	BD Mk X	1400	2700	6.17	1.15	6
	HE Shell Mk 11 M2A1	BD Mk V	1215	3000	6.90	.90	6

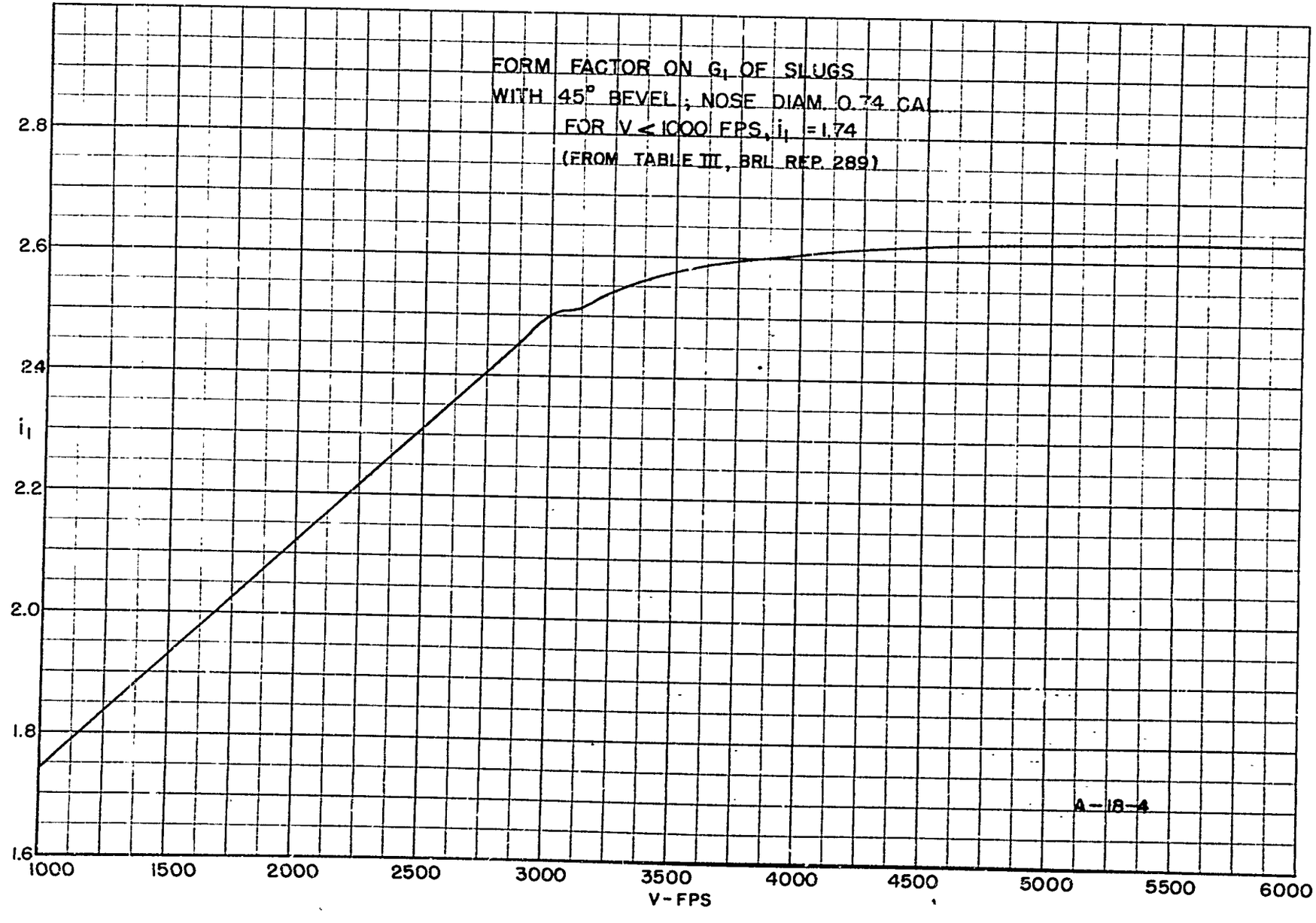
Form Factors of Projectiles

Gun	Projectile	Fuze	Weight lb.	Velocity fps	Ball. Coef.	Form Factor	Proj. Type
16" Gun Mk II Mod. 1 (Navy)	AP Shot Mk 2	BD Mk I	2100	1950	8.06	1.03	6
	TP Proj. M100			2750	7.83	1.05	6
	TP Proj. M102		2240		8.84	.99e	6
Gun M1919MI, M1919MII, M1919MIII	AP Shot Mk 2	BD Mk X	2100	2210	8.32	1.00	6
	TP Proj. M100			2470	8.30	1.01	6
				2750	7.83	1.05	6
	AP Shot Mk 5	BD Mk X	2340	2190	9.74	.94	6
	AP Shot Mk 9	BD Mk X		2440	9.85	.93	6
	TP Proj. Mk 7			2700	9.62	.95	6
Howitzer M1920	AP Shot Mk 2	BD Mk X	2100	1350	7.63	1.07	6
	TP Proj. M100			1550	7.60	1.08	6
				1750	7.82	1.05	6
				1950	8.06	1.03	6

e Estimated

H. P. Hitchcock

H. P. HITCHCOCK


FORM FACTOR ON G_1 OF SLUGS
WITH 45° BEVEL ; NOSE DIAM. 0.74 CAL.
FOR V < 1000 FPS, i_1 = 1.74
(FROM TABLE III, BRL REP. 289)
A-18-4
i_1
2.8
2.6
24
2.2
2.0
1.8
1.6
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
V-FPS